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ABSTRACT

This paper describes a case study of a Mother/Daughter Science Club which was established to explore the issue of adolescent girls' increasingly negative attitudes towards science and math. Data was collected on participants' (n=40, 20 pre-adolescent fifth-grade girls and their mothers) attitudes toward math and science through the use of journals. Knowledge of science-related careers was also assessed before and after the program through questionnaires and small focus group meetings. Results showed that in general the girls in this study were confident of their abilities in math and science. At the beginning of the project 100% of the girls expressing interest in science preferred the life sciences but by the end of the project 25% of the girls expressed an interest in the physical and earth sciences. Many of the mothers related negative experiences from their own school science classes and endeavored to provide more positive experiences for their daughters. The results demonstrated a need for Mother/Daughter Science Clubs beyond the scope of this project. Contains 13 references. (Author/JRH)

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A CASE STUDY OF A MOTHER/DAUGHTER SCIENCE CLUB

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ABSTRACT

Adolescence is a time when self-esteem plummets for females. It is also a time when attitudes toward science and math become increasingly negative for many girls. Research suggests that this tendency may be changed if factors affecting these negative attitudes are addressed. These factors include the lack of female role models, the lack of hands-on experiences for girls, low self esteem, stereotypes of scientists, and low parental expectations.

In an attempt to explore the issue, a "Mother/Daughter Science Club" was established for twenty pre-adolescent girls (fifth grade) and their mothers. This project provided role models in science and engineering for both participants. On a weekly basis, the mothers and daughters met with a professional woman employed in science, engineering, or some other math-related field. They engaged in hands-on activities, interacted informally with the scientist, and learned about the scientist's life.

Data was collected on participants' attitudes toward math and science during the program, through the use of journals. Knowledge of science-related careers was also assessed before and after the program through questionnaires and small focus-group meetings. Results showed that, in general, the girls in this study are confident of their abilities in math and science. Overall, their self-esteem is high. At the beginning of the project, 100% of the girls expressing interest in science preferred the life sciences. By the end of the project, 25% of the girls expressed an interest in the physical and earth sciences. Although the population targeted in this study is somewhat unique in that the majority of the girls' fathers are employed in the physical sciences at a local national laboratory, none of the girls at the beginning of the project expressed interest in the physical sciences.

This study also provided data on the mothers' views of science. Many of the mothers related negative experiences from their own school science classes and endeavored to provide more positive experiences for their daughters. The weekly program was well received with participants asking for it to continue beyond the nine weeks scheduled. The results demonstrated a need for Mother/Daughter Science Clubs beyond the scope of this project.

INTRODUCTION

In recent years, much attention has been focused on the lack of women in science and engineering fields (Bailey, 1992; Kelly, 1976). It is clear that from a fairly early age, girls choose not to take courses in school that would prepare them for careers in fields related to science or math. Their feelings toward science and scientists are not as positive as those of their male counterparts (Baker and Leary, 1995; NAEP, 1978). Several factors have been suggested by researchers as contributing to the negative attitude girls develop toward science and math. These include low self esteem, lack of female role models, low parental expectations, stereotypes of scientists, and lack of hands-on experience in science (Matyas, 1985). The project described in this paper, the Mother-Daughter Science Club, addressed all five of these factors cited as responsible for the lack of interest in science and math by adolescent girls. It was geared toward fifth grade girls (pre-adolescents) and their mothers.

While trying to influence the science interest of these girls by addressing identified contributing factors, one must be careful not to appear judgmental. The spirit in which the project was conducted was one of "We're all in this together." Therefore, the project was conceived as a case study (Lincoln and Guba, 1985; Yin, 1984), eliminating the need for a

control group (the design of which was not clear), and freeing members of the group to express themselves more openly. Attitudes were recorded in journals where the girls' and women's views of science from a "ways of knowing" perspective were obtained (Belenky, et al., 1986). That is, the emphasis is on understanding their personal viewpoint, knowing how their self-concept is related to their construct of scientific knowledge and attitude, and having their own story heard. The project, therefore, became more of a case-study, rather than a strictly methods-driven project.

Numerous studies have attempted to find answers for the question of why women tend to choose career fields other than math and science (Matyas, 1985; Kahle, 1983). Several factors surface again and again throughout the literature. The project described in this paper was an attempt to examine the most commonly attributed factors in formation of attitudes toward science and math in a group of girls at the age most studies suggest is just prior to the downslide that occurs in junior high.

In 1991, the American Association of University Women (AAUW) commissioned a nationwide survey of girls and boys, ages 9-15 (Bailey, 1992). The purpose of the survey was to assess self esteem, educational experiences, interest in math and science, and career aspirations. The study examined the changes in attitudes of boys and girls as they grow into adolescence, and attempted to identify critical processes at work in the formation of attitudes. The most interesting finding of the survey related to self esteem. During adolescence, both boys and girls experience a significant loss of self esteem in a variety of areas. However, the loss is much more drastic and long lasting in girls than in boys. The study suggested that there is a complex relationship between self esteem and choices that students make that may affect their future careers. In this study of 20 fifth-grade girls, assessing the self-esteem of the girls and enhancing their self-esteem were dual goals.

Several studies, including works by Baker and Leary (1995), Fear-Fenn (1992), Granstam (1988), and Kahle (1983) have attempted to identify factors which lead to the low numbers of girls continuing in science and math. They have found that: (1) girls have more negative attitudes toward science than boys; (2) they enroll less often in elective science courses than boys; (3) they reach lower achievement levels in science than boys; and (4) they have fewer experiences with science materials or instruments than do boys.

The researchers mentioned above suggest the following social, educational, and personal factors leading to the problem described above:

- Sex role stereotyping
- Lack of female role models (especially for early adolescent girls)
- Peer pressure
- Teacher expectations
- Classroom and extracurricular activities
- Parental expectations
- Failure to see relevance
- Spatial visualization differences between sexes
- Lack of self confidence.

The authors suggest strategies to address the issues raised. These suggestions include provision of female role models, improvement of relevance by presentation of lessons with real life applications, and provision of hands-on experience with scientific materials and instruments. The most obvious benefit of the Mother-Daughter Science Club was to provide

positive role models for pre-adolescents girls. What is happening in our society now is that girls are closing doors on future opportunities by the age of 12 or 13 because of choices they make with regard to science and mathematics courses and activities. The major goal of this project was to keep girls interested, to encourage them to keep options open, and regardless of their future career choice, to see science as relevant and important.

By including the mothers in the program, the hope was that it would also improve their awareness of science-related jobs, and would help them to see careers in science for women in a positive light. At the very least, by attending the meetings with their daughters, discussions related to science and their attitudes toward it would be more likely to occur between mother and daughter. By having the focus of each meeting be a hands-on project related to the presenter's field of work, two of the factors cited earlier were addressed: the need for science to be seen as relevant, and the need to provide girls with additional experiences with scientific materials and equipment. By having the Mother-Daughter Science Club in the evening, outside the regular classroom, the separate educational setting mentioned by Kelly (1981) was obtained, if only for a small part of the overall educational experience.

It was hoped that by carrying out experiments in a relaxed atmosphere, with support from other women, the girls would feel successful in doing science, thus increasing their self-confidence. Over the long term, this may enable them to withstand the assault on their self esteem that is predicted in the literature as they enter junior high school.

METHODOLOGY

Overview of the Project

The Mother/Daughter Science Club began in January 1994. Table 1 shows that the project ran for nine weeks, with one meeting held per week. The 40 females involved in the project were 20 fifth grade girls and their mothers. The setting was the elementary school science lab to which the girls come with their class on a regular basis throughout the school year. The room is a classroom that is set up with tables and chairs rather than desks. Science materials for the school are housed in the science lab. The mother/daughter teams sat together with three teams to a table.

One evening meeting was reserved for the mothers only. For each of the other eight weeks, a professional woman working in a science or math-related field met with the group. She was responsible for providing a hands-on activity or experiment for the girls and their mothers to explore. The activity was related to the presenter's profession. She also told the group about her work, the training she received, the schooling she had, how she became interested in her field, and a bit about her personal life. The girls and their mothers had the opportunity to ask questions and interact informally. The role models were women from a variety of professions in science and engineering. The professions represented included chemistry, field biology, marine biology, veterinary medicine, electrical engineering, geology, and mechanical engineering. The levels of education ranged from bachelors level to Ph.D. The women were volunteers from the women's outreach programs of the two research laboratories located in town, or were professional contacts, or were personal acquaintances. Each evening program was about an hour and a half long and concluded with refreshments.

Table 1. Timeline of Mother/Daughter Science Club

DATE	EVENT	FORMAT
12/10/93	Announcement of project	Letter with return slip
1/7/94	Initial information gathered	Questionnaire sent to mothers and daughters
1/13/94	Whole Group Meeting 1	Electrical Engineer -activity on rocketry
1/20/94	Whole Group Meeting 2	Mechanical Engineer - infra-red camera
1/24/94	Focus Group 1	Discussion with 5-6 girls over lunch period
1/25/94	Focus Group 2	Discussion with 5-6 girls over lunch period
1/27/94	Focus Group 3	Discussion with 5-6 girls over lunch period
1/27/94	Whole Group Meeting 3	Field Biologist - activity with radio collars
2/3/94	Mothers only meeting	Discussion of project, their perceptions, experiences
2/10/94	Whole Group Meeting 4	Marine Biologist- pelts, skulls, diving equipment
2/17/94	Whole Group Meeting 5	Chemist - activities on chemical reactions.
2/24/94	Whole Group Meeting 6	Mechanical Engineer - properties of materials
3/3/94	Whole Group Meeting 7	Seismologist - mapping earthquake activity
3/10/94	Whole Group Meeting 8	Veterinarian- what is involved in a vet practice
2/15/95-2/28/95	Follow-up Data	Interviews and questionnaires

Training for Presenters

There was a training session prior to the beginning of the program for the women role models. It was based on a training program developed for laboratory scientists and technicians who provide demonstrations for elementary schools. The presenters were also met with individually to review each presentation, its grade-level appropriateness, and the way in which the information was to be presented. The developmental levels of children were discussed with the women, so that they would have an understanding of their audience

Materials

The materials needed varied from week to week, depending on the topic addressed. (See Table 1). Most of the materials were provided by the scientists, some were available for our use through the school, and some consumables were purchased from local sources.

Data Collection Techniques

Questionnaires. Questionnaires were administered to all participating fifth grade girls and their mothers prior to the first meeting of the group. The questions were geared toward obtaining information on attitudes toward science and math, attitudes toward scientists, attitudes toward women and science, and knowledge of careers in math and science fields. Questionnaires were also given to the group one year after the end of the 9-week enrichment program to determine what, if any, changes in attitude and knowledge occurred as a result of participation.

Journals. Each mother and daughter was issued a journal. Each week a different topic was given and the participants were to address the topic in their journal writing for that week. They were also encouraged to write reactions to any of the presentations.

Focus Groups. Small group discussions were held to gain further data on attitudes and experiences. The girls were gathered in small groups over the lunch period during the school day. The purpose of these meetings was to talk with the girls in small groups so that their feelings could be expressed. In the large group setting on Thursday nights, it wasn't possible to have discussions in which all could be heard. The mothers met on one of the Thursday nights when the girls were away at outdoor education camp. All sessions were videotaped.

Coding of Data. Confidentiality was protected. Each participant was assigned a number, which was written on each questionnaire and journal. The list of numbers and participants was kept safely until the data had been gathered. The list was then destroyed. The journals had a front page tear-off page. The name of the individual was on that page, but it was torn off before the journal was turned in at the end of the project.

Overview of Analysis

Naturalistic research techniques appropriate for a case study (Lincoln and Guba, 1985; Yin, 1984) were used to gather as much information as possible. A naturalistic approach was chosen because it allows the researcher to investigate a phenomenon within its context in real life. In the case of the Mother/Daughter Science Club, the desire was to learn about the participants in a way that would give the most information and at the same time, not have the participants feel that they were being analyzed and judged. The data gathered in this study was analyzed in an attempt to find trends in the girls and mothers thinking, especially on issues that were mentioned earlier as contributing to the female lack of interest in science and math.

Study Population

One of the factors to be considered in this study is the rather unique group represented. The community is a town of 50,000 in the San Francisco Bay Area and is home to two major laboratories, where physics and engineering research is predominant. Consequently, many residents of the town are employees of the labs. Many of the parents of the girls involved in the study (more fathers than mothers) are scientists, engineers, or technicians at one of the

labs. Another factor which makes this group of girls unique is that they have received regular hands-on science instruction since the first grade. The school district has an elementary science program for grades 1–5 in which an on-site science specialist provides science learning experiences in a room set up as a science lab. Each class comes to the science lab two times each week for 40 minutes of hands-on science. The science teacher they have had every year has been female. In the district science curriculum, women and other underrepresented groups in science are featured through a monthly "Mystery Scientist " contest. Therefore, the background experiences of these girls most likely will not reflect the level of the average American fifth grade girl.

KEY FINDINGS

The role model intervention program was successful in meeting its goals. Both the girls and the mothers expressed positive attitudes toward science and saw science-related fields as possible career paths. The educational goals of the project, at least in the short term, were met through the Mother/Daughter Science Club. The girls and their mothers were provided with positive role models in science-related professions. The experiences were viewed as positive—based on journal entries, focus group discussions, and observations of the girls at school and at our weekly meetings. The women who were the presenters gave interesting, engaging presentations. They were friendly and related well to both mothers and daughters.

Awareness of science-related jobs was increased in both mothers and daughters. Engineering, in particular, seemed to be an area that the participants knew existed, but they had little information as to what an engineer actually does. The science-related jobs were seen in a positive light. The presenters "obviously love what they are doing," said one mother. Another said that she was glad to see that science careers and raising a family could co-exist.

Possibly the most positive outcome of the project was the increased dialogue between mothers and their daughters. All the mothers indicated in journal writings and in personal comments that they talk with their daughters about the presentations, about their feelings, plans for the future, and what they learned each week. Participation by the mothers caused several of them to remark that they "realized what they had missed" by not taking more of an interest in science. Without the participation of the mothers, this project would have been much less successful. Whether the dialogue continues can only be discerned with longitudinal data. Preliminary information from a follow-up questionnaire one year after conclusion of the project indicates the dialogue continues.

Research has shown that students, particularly girls, need to see relevance in a subject in order to want to study it. One of the goals of the Mother/Daughter Science Club was to show the relevance of science to everyday life. One of the most popular presenters was the seismologist because of the relevance of the topic to life in California. Both mothers and daughters were full of curiosity and asked many questions.

The provision of hands-on experiences related to each presenter's profession was an important part of the project. The more actual contact time the girls had with materials and equipment, the more they liked the presentation. Both mothers and daughters recalled hands-on science experiences positively. All the presentations had a hands-on component that was directly related to a job. This was an important difference from the science lab experiences in their schools, which are hands-on but not job-related.

The girls in this study showed a high interest level in science from the beginning of the study. The majority listed science or math as their favorite school subject. A majority also gave a science-related job as something they would like to do. At the beginning of the project, the girls science interest was solely in the life sciences, particularly animal related occupations. After the project, 25% expressed a strong interest in physical and earth sciences, suggesting that a role model project such as this is effective.

The mothers also expressed interest in jobs related to biology and health. Interestingly, the husbands/fathers in 70% of these families are employed in some type of physical science or engineering. This research suggests that the influence of the father on girls' career preferences is minimal, at least at this age. The girls appear to identify much more strongly with the mother and the mothers' attitudes seem to be influencing their daughters at this stage of their lives.

The case study approach used in this project provided multiple data collecting techniques. The multiple source data provided a better picture of the group than would have been obtained by trying to conduct a controlled experiment. In some instances, one form of data collection was better than another. Generally, the journals were the most insightful for the mothers, and the focus groups gave the most information about the girls. All forms of data collection, however, were valuable; when used in conjunction with other sources, they gave a fairly complete view of the group.

One point that continues to be made is that the influence of the teacher cannot be overemphasized. The mothers, in particular, recalled teachers that made a difference in their lives in terms of choices they made. Unfortunately, the majority of the science education memories were unpleasant for the mothers. Those who did recall positive science experiences recalled teachers who made science fun, who did experiments, who showed the relevance of science to life, and who helped them feel successful in their endeavors.

IMPLICATIONS FOR TEACHERS AND PARENTS

The experience of having mothers and daughters involved in this project was powerful. Both benefited from the weekly activities and gained even more later from the dialogue that ensued from the evening's activities. This research suggests that schools would be advised to involve mothers and daughters in joint learning experiences in science and math. The influence of the mother is great and the mothers in this study seem to want their daughters to have all career options open to them. A project such as this can go a long way toward helping girls to succeed at whatever they choose to do in science.

Another important finding which has implications for both teachers and parents is the idea of valuing hard work versus valuing good grades. Several girls in the study expressed the opinion that they were not good at math because they had to work at it, and they often asked for help. The girls pointed out that they got A's in math, but because it did not come effortlessly to them, they must not be good at it. Teachers and parents alike should encourage and praise hard work and good effort and not just good grades.

Girls need hands-on experiences with relevant applications. Schools and parents can make efforts to give their girls these experiences. Parents, especially mothers, can take their daughters on science-related outings, to museums, to universities. They can enroll in classes together. Teachers must provide regular hands-on science experiences for their students, making sure the girls have equal access to materials and assistance. After school science clubs for girls would provide a single-sex setting for part of their school experience.

Above all, girls must be heard. In the classroom and at home, their ideas and insights must be valued. This may require time spent with girls alone, without the boys. Classroom management issues related to gender need to be addressed. Teachers must be aware of the demand put on their time by boys and take measures to insure that no one group dominates his/her time.

IMPLICATIONS FOR FURTHER RESEARCH

While this study provided important information about a select group of mothers and daughters, the data obtained is of a short-term nature. To see if the Mother/Daughter Science Club had any long-lasting impact on its participants, longitudinal data is needed, including yearly follow-up interviews, questionnaires, or meetings. Preliminary data from a follow up questionnaire administered one year later was received from ten of the twenty pairs of participants. Of those, all seem to have made the transition to middle school (sixth grade) smoothly. They recall experiences from the Mother/Daughter Science Club positively, and at this point are self-assured, as they were a year ago. Further study is needed to follow this group of girls through high school to see what types of choices they make regarding science and math courses.

The project described in this paper was done with a select population. The participants live in a highly educated community. Many of the fathers of the girls work in science-related positions. It would be interesting to do a similar project in a more typical American town and to compare the results to those obtained in this study.

An interesting idea that surfaced in this study that needs further research is the role of the father in influencing girls' career choices. It was interesting to note that despite the large percentage of fathers employed in the physical sciences, none of their daughters was interested in the physical sciences at the beginning of the study. This suggests that the role of the father in influencing girls' preferences is not great. However, more than one of the presenters stated that her father was a scientist or engineer and that it was his encouragement that led to her to a science-related field. The role of the father versus the mother is an area that needs more research. Likewise, the attraction of the girls and their mothers to the life sciences is an area that would benefit from further study.

SUMMARY

Half the participants in this study are at the threshold of adolescence, a time that numerous studies have shown to be a time of self-doubt, anxiety, and loss of self-esteem, especially among girls. At this point in their lives, the girls seem to be full of confidence, and happy with life generally. The other half of the group are the mothers of these girls, women who recall the self-doubt, anxiety, and loss of self-esteem they felt as they went through adolescence. They wish for their daughters an easier transition to adulthood than they themselves had. Results from this study suggest that projects such as the Mother/Daughter Science Club may help make the transition a positive one.

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